Unanswered Questions from U.S. EPA's Urban Heat Island Webcast: Ways to Beat the Heat: Effective Approaches to Heat Island Reduction

August 8, 2012

Questions for Neelam Patel (EPA)

1. **In terms of the impact to water quality, what is the connection between UHI and increased run-off?**

   A: The heat island effect and stormwater runoff can be caused by the same type of urban infrastructure. Surface types, such as traditional roofs and pavements or impervious roofs and pavements contribute to stormwater runoff and to warmer air and surface temperatures. The materials making up these surfaces generally tend to have low albedo (or reflectivity) low thermal emittance, and/or high heat capacity which can, in various combinations contribute to the urban heat island effect.

   The strategies to cool surface and air temperatures and reduce the quantity of stormwater runoff can be the same. These include increasing vegetation and tree canopy which also include green roofs as a potential mitigation strategy. Increasing vegetation can also include community design with more open green space which is a low impact development technique that can help manage stormwater.

   Additionally, higher surface temperatures can increase the temperature of runoff traveling into our waterways. Studies have shown that warmer water temperatures can negatively affect aquatic life.

2. **Are there any federal regulations for UHI? If not, what are the reasons for leaving UHI measures up to individuals or local governments rather than addressing it on a federal level, such as through the EPA?**

   A: There are no Federal regulations specifically for urban heat island. There are Federal programs that support mitigation strategies from, for example, the U.S. Forest Service. There has been draft legislation in the House of Representatives that states Federal building, facilities, or campuses should develop heat island management plans but to my knowledge this legislation was only conceptual.

   Cooling the heat island effect requires addressing a community's unique topographic and weather characteristics. There is no "one size fits all" national solution or standard that can be applied to individual towns or cities. For example, recommending communities to plant X number of Y species of trees to decrease temperatures does not work. Additionally, land use decisions are made at a local level which gives communities to conduct localized analysis to find the most effective combination of strategies to meet local or regional goals.

3. **How does evapotranspiration relate to heat island effect? Can you explain this relationship?**

   A: Evapotranspiration is the loss of water to the atmosphere by the combined processes of evaporation (from soil and plant surfaces) and transpiration (from plant tissues). Evapotranspiration cools the air by using heat from the air to evaporate water.

Evapotranspiration, alone or in combination with shading, can help reduce peak summer air temperatures. Various studies have measured the following reductions:

- Peak air temperatures in tree groves that are 9ºF (5ºC) cooler than over open terrain.
- Air temperatures over irrigated agricultural fields that are 6ºF (3ºC) cooler than air over bare ground.
- Suburban areas with mature trees that are 4 to 6ºF (2 to 3ºC) cooler than new suburbs without trees.

For more information, see the Heat Island Basics (p.7, 10, 12), Trees and Vegetation (p. 3), and Green Roofs (p. 3) available at: http://www.epa.gov/heatisland/resources/compendium.htm.

4. **Why are the high night time temperatures more significant than daytime temps for health outcomes?**

   A: Nighttime cooling provides relief from high daytime temperatures. Urban surfaces absorb rather than reflect more of the sun's energy compared to vegetation and natural ground cover, raising the area's temperature. The urban surfaces release the absorbed energy gradually, which contributes to nighttime cooling.

   Urban geometry, which refers to the dimensions and spacing of buildings, can also impede nighttime cooling. The dense infrastructure in urban areas may obstruct the release of absorbed energy into the cooler night sky. This trapped heat contributes to the urban heat island.

   Continual exposure to heat during the day and at night can affect human health. Reduced nighttime cooling can contribute to general discomfort, respiratory difficulties, heat cramps and exhaustion, non-fatal heat stroke, and heat-related mortality. For more information about the relationship between nighttime temperatures and mortality, see the following studies:

   - Basu, R. and J. M. Samet (2002). Relation between Elevated Ambient Temperature and Mortality: A Review of the Epidemiologic Evidence. Epidemiologic Reviews, Vol. 24, Issue 2, pp. 190-202. http://epirev.oxfordjournals.org/content/24/2/190.short
   - Fischer, E. M., K. W. Oleson, and D. M. Lawrence (2012). Contrasting urban and rural heat stress responses to climate change. Geophysical Research Letters, Vol. 39, L03705, pp. 8. http://www.agu.org/pubs/crossref/2012/2011GL050576.shtml
   - Laaidi, K., A. Zeghnoun, B. Dousset, P. Bretin, S. Vandentorren, E. Giraudet, and P. Beaudeau (2012). The Impact of Heat Islands on Mortality in Paris during the August 2003 Heat Wave. Environmental Health Perspectives 120(2). http://ehp03.niehs.nih.gov/article/info%3Adoi%2F10.1289%2Fehp.1103532

5. **Other countries include a 5th policy response - ventilation. Do you have any information on increasing ventilation in urban areas?**

   A: Ventilation in urban areas refers to bringing in air to replace hot air in an urban environment.

Urban geometry, which refers to the dimensions and spacing of buildings, contributes to the formation of urban heat islands. Heat from buildings that would normally escape into the sky can get trapped in urban canyons, characterized by tall buildings and narrow streets.

Natural ventilation can be increased through land use planning principles that alter the urban geometry to promote wind circulation. Planning techniques include distribution of green spaces among buildings and variation in building height to facilitate wind.

For more information about ventilation as an urban heat island mitigation strategy, see the following studies:

- Shahmohamadi, P., A. I. Che-Ani, K. N. A. Maulud, N. M. Tawil, and N. A. G. Abdullah (2011). The Impact of Anthropogenic Heat on Formation of Urban Heat Island and Energy Consumption Balance. Urban Studies Research, Vol. 2011, Article ID 497524. http://www.hindawi.com/journals/usr/2011/497524/

- Wong, K., E. Ng, and R. Yau (2012). Policies towards Greening, Permeability and Building Separation for Better City Planning in Hong Kong. Second International Conference on Countermeasures to Urban Heat Islands. http://www.coolrooftoolkit.org/wp-content/uploads/2012/04/231140-ng-doc.pdf

6. **Is mitigation/adaptation going to be scenario dependent a1, a2, b1, b2...I would think especially later part of this century...building density with higher population of a2 would be problematic. Heat islands would be happening more and yet "growing cooler" would want that density to accommodate the population with fewer fossil fuels being burned for transportation to jobs, etc. Is this for metros to decide?**

   A: Future greenhouse gas (GHG) emissions are the product of very complex dynamic systems, determined by driving forces such as demographic development, socio-economic development, and technological change. The Intergovernmental Panel on Climate Change's emissions scenarios are alternative images of how the future might unfold and are an appropriate tool with which to analyze how driving forces may influence future emission outcomes and to assess the associated uncertainties. They assist in climate change analysis, including climate modeling and the assessment of impacts, adaptation, and mitigation. The possibility that any single emissions path will occur as described in scenarios is highly uncertain.

   Because we can't know in advance what that scenario will be, and the costs of assuming the wrong scenario could be high, heat island mitigation and adaptation efforts are most likely to occur at the municipal or regional levels, in response to trends and conditions in individual metropolitan areas. Higher building densities and populations would not necessarily translate to stronger heat islands, depending on urban design and the materials used in construction. Policies that encourage or require tree-planting, cool roofs, green roofs, and cool pavements could help cities accommodate future growth and increases in density while avoiding corresponding increases in the heat island effect.

7. **Where can a small community that is unlikely to be able to commission a study obtain information about the size and nature of its heat island?**

   A: Heat islands are measured through two methods: remote sensing of surface temperatures and measurements of air temperatures. Researchers use satellites and other remote sensing instruments to measure surface temperatures. Air temperatures are measured using on-the-ground equipment such as weather stations or hand-held measurement devices.

Remote sensing can be used to estimate the presence or intensity of a heat island in your community. Landsat 5 imagery has a thermal band that can be used to approximate surface temperatures that create a heat island. A basic understanding of using GIS for processing remotely-sensed data is needed to analyze and interpret this data. To determine the intensity or presence of a heat island with more accuracy, the emissivity of the land cover should be included in the analysis. It is possible to estimate the emissivity for land use land cover data by assigning estimated values for different land cover types (e.g., paved surfaces, forested areas, etc.)

Air temperatures can be used to help communities determine whether there is a heat island in their community. For example, temperatures from weather stations can be collected during the day or the night throughout the year or the season at times when a heat island is expected to be present. It is useful to pick one weather station near the downtown area and a second one that is in an open area outside of the more developed areas of the city with little infrastructure. Collecting information from weather stations at the same times on different days can provide information on whether a heat island is present. Comparisons between temperatures over different land covers both in and outside of the city will improve interpretation of temperature data collected. The numbers from this approach provide only an estimate that is valuable with site specific interpretation. For example, temperatures take over a paved surface are expected to be higher than those taken over a vegetated surface regardless of whether or not there are heat island effects. Therefore, temperature measurements should be taken over similar land covers both inside and outside of the city area for documentation of heat island effects.

Small communities can work with local universities or Federal agencies such as the Forest Service who may offer funding or technical assistance opportunities to estimate their heat island effect.

For more information about measuring heat islands, visit the EPA Heat Island Measuring Heat Islands page, available at: http://www.epa.gov/heatisld/about/measuring.htm.

Presentations of case study examples of heat island measurement are available at: http://www.epa.gov/heatisld/resources/webcasts.htm#measuring.

8. **Most states have weatherization programs – Do you have information on how improving weatherization/ insulation can help with heat island impacts?**

   A: Weatherization is the process of making homes more energy efficient at no cost to the residents. Weatherization programs can be used to install energy efficiency measures with cooling benefits, such as cool roofs and screening and shading devices. In this respect, weatherization programs can mitigate heat islands and protect public health, as well as reduce energy costs. For more information about this effort, see Weatherization (page 7), available at: http://www.epa.gov/hiri/resources/pdf/ActivitiesCompendium.pdf.

9. **Do you have any information on the impacts of urban heat islands caused by solar panels?**

   A: Solar panels can be used as a shading technique by deflecting heat from going into buildings or parking lots. However, the photovoltaic (PV) cells of the solar panels themselves generate heat from their processes, which then can heat up the surrounding air. Employing solar panels as a heat island mitigation effort should be evaluated based on local weather conditions and surface canopies.

Scientists have studied the use of solar panels as a shading technique. A study in Tokyo, Japan found that large-scale installation of PV panels has a negligible effect on the building canopy temperatures, but energy consumption for cooling may be reduced by 2 to 10 percent due to the shading effect. Other studies looked at the effect of installing PV canopies to shade parking lots. More details on the studies are available:

- Genchi, Y., Ishisaki, M., Ohashi, Y., Takahashi, H. and A. Inaba (2003). Impacts of Large-Scale Photovoltaic Panel Installation on the Heat Island Effect in Tokyo. Fifth Conference on the Urban Climate. http://nargeo.geo.uni.lodz.pl/~icuc5/text/O_14_3.pdf

- Golden, J.S. (2006). Photovoltaic canopies: thermodynamics to achieve a sustainable systems approach to mitigate the urban heat island hysteresis lag effect. International Journal of Sustainable Energy, Vol. 25, Issue 1, p.1-21. http://caplter.asu.edu/docs/smartWebArticles/SustainableEnergyArticleOne.pdf

- Golden, J.S., J. Carlsonb, K.E. Kaloushc, and P. Pheland (2007). A comparative study of the thermal and radiative impacts of photovoltaic canopies on pavement surface temperatures. Solar Energy, Vol. 81, Issue 7. http://www.sciencedirect.com/science/article/pii/S0038092X06002908

10. In Syracuse, NY, recent research suggest we have a large CO2 dome, comparative to other NYS cities. How might this impact UHI? Does this offer reasons for reducing urban traffic wherever possible?

A: While greater carbon dioxide concentrations contribute to overall atmospheric warming, the urban heat island effect is caused mainly by factors such as the radiative and thermal properties of urban infrastructure. While this is an area of active research, it currently appears that higher local carbon dioxide concentrations may contribute only slightly to the urban heat island effect. See, for example, the following paper:

- Balling, R.C. Jr., R.S. Cerveny, and C.D. Idso (2001). Does the urban CO2 dome of Phoenix, Arizona contribute to its heat island? Geophysical Research Letters, Vol. 28, No. 24. http://www.atmos.berkeley.edu/~inez/MSRI-NCAR_CarbonDA/papers/barnet_refs/2000GL012632.pdf

Reducing the amount of local heat generated from human activities, which can get trapped in an urban area, can contribute to the heat island. Other traditional strategies to reduce urban heat islands, such as trees and vegetation and green roofs, produce multiple benefits including lowering energy demand, air pollution, and greenhouse gas emissions. Thus, advancing measures to mitigate urban heat islands also helps to address local carbon dioxide domes and global climate change.

11. What if you already live in a desert-like area?

A: Desert-like areas may or may not experience the urban heat island effect, depending on the built environment. Rural areas in the desert may have high temperatures during the daytime but may experience relief from cooler nighttime temperatures. Urban areas in the desert are likely to experience the urban heat island, with higher temperatures during both the day and night compared to rural areas.

Regardless of the amount of development in desert-like areas, communities can benefits from cooling efforts, including cool roofs, cool pavements, native vegetation, and green roofs.

12. Have heat island measures been fully incorporated in any SIP as a control measure?

A: I do not know of any SIPS that incorporate heat island mitigation measures as a control measure. There have past modeling exercises as part of efforts to include heat island measures into the air planning process, possibly by incorporating these as emerging and voluntary measures or weight of evidence, but to my knowledge, these have not been included in final SIPs. Some air quality management districts in California are investigating the potential use of heat island measures in the air quality planning process.

13. Should reflective roofs even be considered to address heat island effect given that they do reflect the sunlight back up to the atmosphere where the temperature is increased as a result of this light (energy) not being able to escape out into space?

A: Natural materials such as soil and vegetation help reflect sunlight back into the atmosphere. The urban heat island effect occurs in part because man-made materials such as pavements and buildings absorb the sunlight, rather than reflect it, causing the temperatures of the surface and surrounding air to increase. All of our recommended strategies (cool roofs, cool pavements, green roofs, and trees and vegetation) mitigate the heat island effect by increasing the reflectivity of the urban environment.

Greenhouse gases trap only certain types of energy in our atmosphere. Incoming sunlight and reflected sunlight are energy in the form of short-wave radiation, which is able to pass through the greenhouse gases in the atmosphere. Sunlight that is absorbed by surfaces on the earth is reradiated back in the form of long-wave radiation, which gets trapped by greenhouse gases in the atmosphere. Thus, reflecting sunlight should not contribute to global atmospheric warming.

For more information, see Urban Heat Islands, Climate Change, and Global Warming (page 6), available at: http://www.epa.gov/heatisland/resources/pdf/BasicsCompendium.pdf.

14. Are there any cities in the North using cool pavement or cool roof technologies? It seems that in the winter, we would want some absorption of heat.

A: It is true that some communities may benefit from the wintertime warming effect of urban heat islands. However, studies find that winter penalties of strategies such as cool roofs are often much smaller than summer savings. See the individual chapters of EPA's *Reducing Urban Heat Islands: Compendium of Strategies* for information on annual cost-benefit analyses of these technologies: http://www.epa.gov/heatisland/resources/compendium.htm. Additionally, urban heat island mitigation strategies provide other year-round benefits such as improved air and water quality.

There are multiple localities in the North that are implementing cool pavement and cool roof technologies. Case studies of these heat island mitigation actions are available at http://yosemite.epa.gov/gw/heatisland.nsf/HIRIMitigation?OpenView&count=500&type=Cool%20Pavements and http://yosemite.epa.gov/gw/heatisland.nsf/HIRIMitigation?OpenView&count=500&type=Cool%20Roofs.

15. **Are green roofs always a good heat island mitigation measure?**

    A: It really depends on multiple factors. The short answer is no. An irrigated green roof will generally remain fairly cool during a hot summer day. This results in less convective heat flux to the urban atmosphere than a dark membrane roof. So, during the peak heat of a summer day the green roof is usually a UHI benefit relative to a dark roof. If you are comparing the green roof to a white membrane roof the green roof may be slightly warmer or cooler than the white roof during the day.

    The interesting twist to this question is that a green roof is a thermally massive system that will remain warmer than a black (or white) membrane at night. When a thin roof membrane is exposed to direct sunlight it may heat up to 130 F or more during a hot summer day. At night, however, the membrane has so little mass that it is able to cool off relatively fast (black and white membranes at 3am are about the same temperature regardless of how hot the black membrane was at 3pm). The cooling is accomplished through a combination of convection and long-wave radiation. Through long wave radiation the membrane is able to emit enough heat so that it CAN actually be cooler than the ambient outdoor air temperature. A green roof, because of its thermal mass will generally remain above the ambient air temperature at night. For more information, contact David Sailor at sailor@pdx.edu.

16. **What should be considered when building green roofs and what are the best circumstances for green roofs to be used as cooling strategies?**

    A: Type of vegetation: low water use means less evaporative cooling benefit but plants that might better tolerate drought conditions. Depth of soil: thermal storage is a potential UHI and building energy detractor. Will irrigation be used? Does the city naturally cool off much at night during summer heat waves? (e.g., Portland Oregon cools off enough that the added heat at night may not be much of an issue while the cooling during the day could be advantageous. The same is likely not true for many other cities). Does the city get much summertime precipitation? How deep does the soil need to be to keep plants alive in extreme conditions?

Questions for Brian Stone (Georgia Tech University)

1. **To what extent is the heat island effect increasing estimates of the increase in world temperatures (given that many measuring stations are in urban areas)?**

    A: That's a great question. It kind of highlights the reason why there is a significant emphasis on global temperature and often there's not as mentioned this on urban temperatures and that if you're interested in measuring how rapidly the planet (inaudible) warming and you're going to be using the surface weather stations around the planet and most of these stations are in or close to cities, and so because cities have their own warming mechanism, relying on too many of those urban stations will bias your global temperature record and so the way that's dealt with is that this global databases that are looking at annual temperature change are statistically adjusting the urban weather stations.

    And so that is you know essentially obscuring what's happening in the cities and if you're interested in global scale temperature changes, it's not such a big deal because cities only constitute two to three percent of the global land surface. So while cities are a small percentage of the planet as a whole in terms o geography, they account for most of the inhabitant on the planet and so they're very important in the sense of the places people live and the place where we're generating (inaudible) greenhouse gases.

And so what we do is kind of exactly the opposite of what the global climate scientist are doing. We look just at the urban weather station. We don't statistically adjust them, and then we compare there warming trends to what's happening either right outside of them or globally to see how much more rapidly they're warming. That was that the idea – the amplification rate that I was talking about. And so most (inaudible) in the U.S. are amplifying that ground warming rates by about 100 percent. And so that's how we control for the global versus the urban trends.

2. **Brian - in your book, Houston is shown as cooling while Atlanta is getting hotter (Fig. 3.8 - both sprawling growth areas). Any thoughts on this?**

   A: While the majority of large US cities exhibit a clear trend of heat island growth over time, a minority of cities — about a quarter of those in our database — exhibit a stable on declining heat island over time. While all cities are hotter than surrounding rural areas on average, in some cases the city itself is not warming faster than nearby rural areas or is actually warming less rapidly over time. There are many potential explanations for a stable or declining heat island. Many of these cities, including Houston, are situated near coastal areas, in which the proximity to a large body of water is likely to drive significant atmospheric mixing, which may diminish heat island formation by distributing urban heat more widely though the region. Other cities with stable or declining heat islands tend to be located in rustbelt areas of the country, where slowed economic growth over time may be permitting urban tree canopies to rebound, offsetting the growth in the urban heat island. To answer this question with any precision for a particular city, we would need to examine the unique regional characteristics at work. For those interested in examining the urban and rural temperature trends in proximity to the large US cities in our database, individual city trends can be found on our Urban Climate Lab website (click on circles to bring up trends for each city): http://urbanclimate.gatech.edu/urbanclimatedata.html

3. **We have high and increasing asthma rates in Syracuse, NY. Specific to asthma, does reducing UHI directly help, e.g. in reducing ozone production, heat, and other things like mold growth?**

   A: I am not aware of any studies which address this questions directly — the role of UHI in asthma — but elevated urban temperatures have been linked directly to an increase in the number of high ozone days. Based on this association, the potential for a connection between UHI and asthma seems strong. For a detailed assessment of the association between urban heat and the number of ozone alert days per year, please see our study titled, "Urban Heat and Air Pollution: An Emerging Role for Planners in the Climate Change Debate" -- available through the Ga Tech's Urban Climate Lab: http://urbanclimate.gatech.edu/publications.html

4. **How crucial is pavement and rooftop albedo? I ask in the context of using remote sensing/aerial photography to map urban areas and impervious surfaces. Would maps showing brighter and darker pavement/roofs be useful? We are doing this for some pilot cities in the EPA National Atlas of Sustainability.**

   A: Surface and roof albedo combined are a major driver of urban heat island formation. Modeling studies have found cool roofing and paving materials to hold significant potential to reduce urban temperatures, particularly if installed city or region wide. For example, a study in Los Angeles found a 15% increase in citywide albedo to reduce downtown temperatures by up to 2C. The development of maps illustrating low and high albedo surfaces would be highly useful in targeting albedo enhancement programs, so it's great to learn of this effort.

Questions for Brendan Reed (Chula Vista)

1. **What was the science that informed the working group? Were there any studies done on specific conditions in Chula Vista (i.e. the city's specific energy balance)?**

   A: In the San Diego region, the San Diego Foundation created a study called "Focus 2050" to look at climate change impacts to our region in year 2050. It was inspired by a similar study completed in Kings County, Washington. The Foundation's Focus 2050 report collected and synthesized the best available data from a number of local agencies and research institutions, such as the Scripps Institution of Oceanography. The Focus 2050 study provided a great starting point for the City's vulnerability assessment and climate adaptation priority setting.

2. **Do you expect developers to resist requirements to comply with new standards? How will you get them to "buy in?" If required to comply with new standards the cost will be passed on to the consumer. How will this affect new home starts?**

   A: The City of Chula Vista has learned from previous climate action planning efforts to include all relevant stakeholders early in the process. As such, local developers and the business community was invited to participate on the City's Climate Change Working Group, which developed the climate adaptation strategies. They provided valuable insight and help in selecting appropriate adaptation strategies for our community.

   We have found that most of our initiatives have been able to be achieved at no or minimal incremental cost. For example, the Cool Roof requirement is expected to add only $75 on average to the cost of a new single-family home and in many instances there is no cost difference between traditional roofs and 'cool' roofs.

3. **When will the Chula Vista Cool Pavement Study be released to the public? Did your cool pavement study include a look at how those different paving technologies would hold up under high heat? (e.g. will they buckle during a heat wave or under heavy vehicles like buses and trucks).**

   A: The Cool Pavement Study being conducted should be released by the end of September. Due to the limited budget, the report is really a qualitative assessment of different 'cool' paving technologies and their appropriate applications. Some of the factors of interest include each technology's Solar Reflectance Index, overall sustainability, incremental cost, long-term durability, and maintenance costs.

4. **How do you (or will you) implement the cool paving requirement - as a condition of approval? Only for new development projects or also for repaving?**

   A: The implementation of any 'cool' paving requirement will be determined by the results of the Cool Pavement Study. I suspect that the study will lead the City to incrementally incorporate cool paving technologies into design guidelines or "best practices" as more information on the technologies is collected and understood over time.

5. **Is it difficult to put solar (passive and/or panels) on cool roofs?**

   A: Nope … 'cool' roofs can be made out of asphalt or clay shingles (similar to traditional roofs) and can support solar installations.

6. **Do Green roofs meet the cool roof standard?**

   A: The City's Cool Roof standards are based on CalGreen Tier 2 requirements (which identify a minimum SRI value). Green roofs should have no problem meeting the criteria.

7. **Can you say more about the "credit' for existing trees? 150% of what?**

   A: As part of the new City Council-approved Shade Tree Policy, new parking lots have to be designed to have 50% shade cover of parking stalls. If the project proponents preserve an existing tree as part of the new parking lot, the tree's shade coverage is given "extra" credit towards meeting the 50% requirement. For example, an existing tree with shade coverage of 50 feet (in area) would count as contributing 75 feet in area to the 50% requirement.

8. **Is Chula Vista requiring that new shade trees be "native"?**

   A: The new Shade Tree Policy does not require that shade trees be native. However, the trees must be "water-wise" and can not be invasive.

9. **Are the costs of cool residential roofs $75 per house or per square foot of residential roofing?**

   A: $75 per single-family house is the average incremental cost increase from requiring 'cool' roofs.

10. **What is SRI? You mentioned this in your slide regarding a Tier 2 CalGreen requirement.**

    A: SRI stands for Solar Reflectance Index, which is incorporates solar reflectance and thermal emittance into a single value. For more info, please visit http://gaf-sustainability-blog.squarespace.com/gaf-sustainability-blog/2011/12/9/whats-solar-reflective-index.html.

11. **Are there opportunities for "citizen science" public participation in temperature monitoring to assess efficacy of cool pavement etc?**

    A: This is a great idea and one that the City hopes to pursue once cool pavements have been installed as a pilot project etc.

Questions for Matt Grubisich (Texas Tree Foundation)

1. **A number of questions on your $ benefit calculations. How do you estimate the benefits of tree plantings ($102 million per year after 40 years). iTree model? Do you measure and verify these savings?**

   A: Yes, we did use the (i-Tree) model and we're in the process that we've done numerous UFORE studies that are out at Dallas Forth Worth Area, so we are able to kind of even take those numbers and kind of even more centralized and for the Dallas Forth Worth Area and we haven't started to look at the what would benefit these trees are provided that we've just – we've just planted. This program is just a couple of years old so we're only about two or three years into the planting process.

So that's something that we're developing now is how do we go back and look at this and are we really making a difference and are those benefits really what they say they are. So hopefully I'll something more in about five years on that one.

2. **Where does the temp data come from? Is there a publically available database?**

   A: The temperature data was done through HARC, the Houston Advanced Research Center through the grant through EPA through the Sustainable Skylines Initiative, and you can find the report on that online, just go to Dallas City Web site. You can find it there or there in Office Environmental Quality and the entire report is on there but that was a one-time snapshot of temperature values taken I think in the 2004. So that's something else that we would plan on doing probably in the next probably five to six years as redoing that study to see if we're having an effect in those areas.

3. **When planting trees, do you take into consideration the overhead electric power distribution system. What has been your experience with vegetation management and electric power distribution?**

   A: Oh, always. And as I'd mentioned in the report that we are actually able to get the power line information from the power company and so that was included in that roadmap and you know so there's some – of those 1.8 million locations, not one of them is underneath the power line, at least ones that we had GIS data for. In any project that we do you know obviously, you have to go on and look at the site and that's how – it's the first thing that we take into consideration is overhead borrowing.

4. **Is Texas following a native tree policy?**

   A: Yes, we plant – we recommend all native trees or well adapted. It's hot and dry and so the heat is here, our (inaudible) is pretty limited and so the heat from getting too much a monoculture for instance. We have way too many red oaks and live oaks down here. So we don't plant a lot of those anymore, but we will – but everything that we do plant is either adapted

5. **What is that publication on your Tree Strategies for Heat Island Reduction page? How can I get one?**

   A: http://www.harc.edu/ProgramAreasProjects/AirQualityClimate/DallasUrbanHeatIslandStudy/tabid/299/Default.aspx

6. **On your slide "Dallas Roadmap to Tree Planting and Planning). How were temperatures determined (satellite or aircraft)? What explains the significant temperature changes between city blocks?**

   A: The thermal image of Dallas County surface temperatures was developed from 2006 ASTER satellite imagery taken on September 28, 5:25 pm. The hotter surfaces, shown in red, range upwards above 150ºF. The light blue-green areas are cooler, more vegetated areas, as seen along the Trinity River Basin. The dark blue areas are cloud cover that was present at the time the images were taken.

Air temperatures were measured at about 5 feet above the ground, surface temperatures from satellite data show a snap shot in time of various surfaces, particularly flat, horizontal surfaces of rooftops and pavement. Some surfaces, such as barren soil and plowed agricultural land have high temperatures, but change rapidly as crops are grown or soil moisture changes.

7. **Matt, are you also partnered with The Arbor Day Foundation and the Texas Tree Survey? As a member of one of our parks non for profit "Friends" group and a professional in the energy efficiency and sustainability sectors, what can our citizen sponsored and manned local park boards do to help support your efforts in Dallas and the surrounding communities as well as influence those around the US?**

   A: Learn all you can and get involved! Volunteer, get on your local parks board, City Council, HOA Board, or Planning & Zoning (P&Z) commission. Don't sit back and wait and expect others to make a difference! Remember "act as what you do makes a difference, because it does!"-*William James*

8. **Was your GIS tool developed specifically for you? Do you have more information available on the specifics of the tool?**

   A: Yes our Roadmap was developed specifically for the City of Dallas. If you would like more information about the Roadmap and how it was developed please contact me and I'd be happy to answer any of your questions. matt@texastreesfoundation.org

9. **Are there really places in Dallas where the temperature gets to 130 F?**

   A: Yes, I've measured surface temperatures on asphalt in the middle of August as high as 160 F!! Imagine what the air temperature is just above that surface!!

10. **About how difficult & how expensive is it to go back & plant trees in parking lots that are already paved?**

    A: In most cases it can be more expensive then doing it right the first time and you still have to deal with adequate rooting space for the trees. (See question 12)

11. **If we have rudimentary GIS skills, is there any available simplest GIS 'recepie(s)' for inventorying our city's UHI for prioritizing 'hot spots'? For example, are our best opportunities attending to parking lots, roads, roofs, or...? We're open to learning how to tap remote sensing data, and how about open-source software.**

    A: I am far from an expert in GIS and remote sensing which is why are partnerships were so key to completing this project. If you would like to know who we used and a recommendation please contact me and I can put you in touch with someone that can better answer this particular questions. matt@texastreesfoundation.org

12. **What can you do to improve tree health in streetscapes? I just had a major irrigation leak because of the Sissoo roots. The landscaper placed the irrigation line right in the root area.**

    A: The Sissoo, or Indian Rosewood tree, is a great tree for the more arid regions of the country. The negative is that it's a prolific rooter and will interfere with sidewalks, sewer lines, and irrigation lines more than other trees will.

On the larger note of growing healthier trees within streetscapes and other urban environments it comes down to soil volume. A typical urban tree needs 1000 cubic feet of quality soil to maintain a healthy mature tree. In most urban areas this much space is hard to come by but fortunately there are products such as Silva Cells and Structural Soils on the market that allow you to maximize your rooting volume without sacrificing parking spaces or walking areas.

A must read on this subject is; *Up By Roots: Healthy Soils and Trees in the Built Environment*, by James Urban, 2008.

Questions for Normal Muraya (Austin Energy)

1. **What is TPO? What is a TPO and a Ballasted roof?**

   A: I remember what the acronym for TPO, the ballasted roof is where you have a flat built of roof and then you put rocks or pebbles or gravel on that which essentially ballast it so that it keeps the weight down on there, and the advantage of that rock as if they are least (inaudible) and more reflective than the black rubber roof.

   The TPO is just a – it's a type of membrane that would be put on there which is – which are – which would have that insulation, as well as that reflective surface. Some reason I – the – can't remember what the acronym but we can reply that with the questions that will be sent in. Actually, it means thermoplastic polyolefin.

2. **Is there any way to treat asphalt roof tiles as part of a cool roof program? Short of replacing the tiles.**

   A: Yes, it is. That was the other option – instead of the TPO, you could go with a spray paint. Paints do not last this long but you actually achieved initial much cooler temperatures and, of course, if you're diligent, you can always come back a year or two later or a couple of years later since the cost is very low.

3. **Are you aware of if the black rubber membrane roofs used in NE and other parts of country or more in south and TX?**

   A: N.A.

4. **How do you ensure that wind energy is used by electric vehicles - do you place microturbines at charging stations or is it through Austin Energy's overall electricity content?**

   A: No microturbines are utilized or any other absolute direct requirement of wind. In 2009, it was demonstrated that for vehicles that surrender charging control, Austin Energy engineers can track wind. An indirect strategy is recommending charging between 1 am to 6 am when wind predominates the grid load mix and is on margin. In addition, all City owned facilities are on 100% green energy.

5. **Does Austin make exceptions to the cool roof code in cases where the reflectance into neighboring buildings is a nuisance?**

   A: Rare exceptions can be made.

6. **How does PV sequester heat out of the air?**

   A: The PV panels absorb 10-15% of sunlight, reflect about 4%, while the remainder is converted to heat. This 20% is better than the 5% in black roofs but worse than 75% reflective roofs. Hence the benefit to the heat island is indirect: shading roofs so less heat load in buildings to lower a/c run time and generating electricity so less heat engine at the power plant.

7. **Do you think that interest in LEED certification raises awareness for UHI and addressing it?**

   A: LEED certification process addresses environmental issues and awareness that overlap UHI.

8. **How much do internal combustion engines for transportation contribute to the urban heat island effect in Austin?**

   A: I do not have data available.